APPENDIX 1

DRAFT EIS PUBLIC MEETING MINUTES



Minutes: Draft EIS Public Meeting December 17, 2003

Meeting Location: Park Lake Homes Boys & Girls Club Community Room, 5:00pm

- Attendees:
 34 signed-in Park Lake Homes residents, King County officials, KCHA staff, consultants, and the public
- Residents were grouped by languages for interpretation.

Attachments:

- Draft Environmental Impact Statement Notice;
- Comment sheet for completion and submittal to KCHA;
- SEPA and NEPA Environmental Impact Statement Process;
- Attendance Sign-in Sheets; and
- Power Point Presentation.

Meeting Purpose: to provide residents and the public an opportunity to provide comments to KCHA and King County concerning the Draft Environmental Impact Statement (EIS) dated November 2003.

Welcome & Introduction: John Eliason, HOPE VI Development Manager, opened the public meeting. He introduced Greg Borba of King County DDES who has been part of the overall partnership with the Housing Authority in producing the Draft EIS; Richard Weinman, lead consultant from Huckell/Weinman Associates, responsible for producing the document; Mark Stewart from Huckell/Weinman who worked on the technical details to produce the document; Tim Locke from KCHA who recorded the meeting; and Rebekka Goldsmith, Relocation manager from KCHA. This was not a Relocation meeting and questions about relocation were not asked or answered, Rebekka was at the meeting to support the staff.

Richard Weinman went over the state laws and results of the Environmental Impact Statement. He has been one of many people helping KCHA with the Greenbridge/HOPE VI master plan project, resulting in the Draft EIS, a big book with information about Greenbridge and the environment. He described what the Draft EIS says, what it's about and why it was done:

At the Scoping meeting on February 26, 2003, the rule and laws that KCHA has to follow to be allowed to build Greenbridge were talked about. This includes the national environmental policy act (NEPA) and the state environment policy act (SEPA). The law requires that the Housing Authority and King County DDES together study and tell

people how Greenbridge could change the water, air, animals, plants, and the neighborhood people live in. It is called an EIS. At this meeting and over the next few weeks residents and the public will have a chance to read the EIS and to make comments about it. He explained how the EIS process works and the different ways to give comments.

The following 4 steps of the EIS process were described:

- 1. Scoping. In February 2003 the Scoping meeting occurred, a chance for the public to tell KCHA and DDES what's important for them to study.
- 2. Draft EIS. This thick book is the first of 2 that tells what could happen to the community and the environment if Greenbridge is built. It was published on November 21 and KCHA put up signs and announcements in newspapers that it was published and announced the meeting date.
- 3. Draft EIS comment period. There are a number of ways to comment on the Draft EIS: Speaking at tonight's meeting, filling out a comments form with written comments, leaving it or mailing it to KCHA. The Draft EIS is available to read and an information sheet was provided that lists all the libraries and other places where the document can be found. The Draft EIS can also be purchased from KCHA and is on the King County DDES web site. January 5, 2004 is the deadline for comments to be received by KCHA or DDES.
- 4. Final EIS. This will also be a big book with changes to the document based on comments received.

Richard Weinman further explained that during the February meeting KCHA and King County DDES were told about areas of concern. These included housing, traffic, traffic safety, crossing the streets safely, open spaces and parks, trees, and recreational facilities. Overall, there would not be a very big impact to the environment that couldn't be avoided, reduced or minimized and there would be many positive changes that would occur as well. Regarding the natural environment (soils, air, water plants animals and fish) the Draft EIS found there would not be adverse or bad impacts that could not be mitigated or reduced. The same was also found for the human environment, neighborhoods, housing, parks, sewer and water, lighting, energy, noise and historic preservation. The issues of most concern expressed at the February meeting included:

Transportation: The Draft IES states there would not be a big increase in traffic or traffic congestion from Greenbridge. There would be many new streets and sidewalks built. They would be safer for people walking or riding bicycles and there would be enough parking.

Parks and Recreation and Community Facilities: There would be 13 acres of parks and open space plus the playgrounds for the elementary school would be available for the neighborhood and Greenbridge residents to use. There would be new parks and playgrounds built throughout the community. There would also be a new neighborhood center where community services would be located.

Housing: Housing was the third thing that many people were concerned about at the February scoping meeting. Greenbridge would construct between 900-1100 new rental and for-sale housing units. All low-income units would be replaced either onsite or offsite. Relocation assistance would be provided and a new mixed-income community would be created.

Richard Weinman stated that this has been a very quick summary of the major things people were interested in at the last meeting. If residents or the public are interested in reading the Draft EIS, handouts were provided showing where the document is available.

It was asked whether there were any questions about what had been said. No questions were asked. Comments were requested that will be answered in the next book.

Question: When's the next meeting?

Answer: There's not another meeting on the EIS. There will be a public hearing when King County DDES is making a decision about the project. The KCHA may have other meetings to answer questions as well. In the spring there will be another EIS published that will have more information about the project and will answer questions.

The floor was opened for comments to the Draft EIS. There was a second call for comments.

No additional comments or questions were received. The Draft Environmental Impact Statement public comment period of the meeting was closed.

The meeting adjourned 6:15pm.

APPENDIX 2

GREENBRIDGE WATER QUALITY TECHNICAL MEMORANDUM

A.C. Kindig & Co.

12501 Bellevue-Redmond Road, Suite 210 Bellevue, Washington 98005-2509

425 638 0358 fax 425 455 8365

Technical Memorandum

Date	April 15, 2004	Project Name	Greenbridge
То	Mr. Richard Weinman Huckell/Weinman Associates, Inc.	Project Number	216
From	Andy Kindig Dana Zlateff	Regarding	Greenbridge Water Quality Narrative

This memorandum was prepared to assist in preparing responses to comments on a Draft Environmental Impact Statement for the Greenbridge King County Housing Authority proposed project. In a letter dated March 26, 2004 from Greg Borba (King County) to Richard Weinman (Huckell/Weinman Associates), King County listed questions related to impacts of phosphorus in stormwater from the project on Lake Garrett (a.k.a. Hicks Lake). The comments related to the following:

- 1. The status of Lake Garrett with regard to Section 303(d) report listing as water quality limited by the Washington State Department of Ecology (Ecology) to the US Environmental Protection Agency;
- 2. The status of Total Maximum Daily Load (TMDL) plans being prepared by the Washington State Department of Ecology for Lake Garrett;
- 3. Disclosure that the Draft Salmon Creek Basin Plan and draft update to the (1998) King County Surface Water Design Manual propose that new development in the Lake Garrett watershed provide Lake Protection Standard water quality treatment for stormwater;
- 4. Providing analysis of the impacts of changes in phosphorus loading to Lake Garrett resulting from the project, including recommendations for mitigation warranted by those impacts; and
- 5. Consider whether additional mitigating measures are warranted, such as the Lake Protection Standard for runoff from Greenbridge discharging to the Lake Garrett basin, contributing to a mitigation project to discourage waterfowl use of Mallard Lake, or contributing to alum treatment in Lake Garrett.

To prepare responses to the five comments above we examined the DEIS, met with Goldsmith & Associates, Inc. to discuss the preliminary Drainage Control Plan, contacted Ecology staff with responsibility for the Lake Garrett TMDL that is being drafted, and requested and received specific information about project planning related to phosphorus source control measures and construction planning.

The proposed Greenbridge Preliminary Plat includes 93 acres owned by the King County Housing Authority and approximately 5 acres owned by the Highline School District. The existing site includes 569 single-family residential and duplex units, a community center, and other commercial and mixed use buildings (King County Housing Authority 2003). The project proposes to redevelop the site to contain between 900 and 1,100 residential units, which include 250 single-family detached units, 400 single family attached or townhome units, and 450 multi-family units (King County Housing Authority 2003). The project would also re-develop the commercial and community facilities to include a renovated community center, Headstart and childcare facility, and career development center.

Hydrologic Setting

The Greenbridge site lies within both the Salmon Creek Basin and the Duwamish River Basin. A total of approximately 52 acres of the Greenbridge site lies within the Salmon Creek Basin and approximately 46 acres is located in the Duwamish River Basin. The Salmon Creek Basin is the only basin that is assessed in this analysis.

The Greenbridge site located within the Salmon Creek Basin drains either west or south, ultimately to Lake Garrett. The 17 most westerly acres of the site located between 9th Place SW and 9th Avenue SW drains west to White Center pond (this area of the basin is herein referred to as the western on-site Garret Lake Basin). The White Center pond is a King County regional detention facility that drains south to Mallard Lake. Mallard Lake drains southeast in a 48 inch storm drain before discharging to an open channel (pre-settling facility) that flows to the north end of Lake Garrett, approximately 1.5 mile downstream of Mallard Lake (Goldsmith & Associated 2004a). The remaining approximately 35.5 acres of the site is conveyed east to 8th Avenue SW and than drains south towards Lake Garrett (this area of the basin is herein referred to as the eastern on-site Lake Garrett Basin). Lake Garrett includes a King County maintained drainage control facility that discharges through a pump station and flows to the southwest (Goldsmith & Associated 2004a). The closed conveyance system runs parallel to Salmon Creek and discharges to the Puget Sound.

Comment 1: Lake Garrett Status with Regard to Section 303(d) Threatened and Impaired Water Bodies

Section 303(d) of the 1972 Federal Clean Water Act (CWA) requires states to identify and list threatened and impaired water bodies (Ecology 1998). The CWA requires the list to be updated and submitted for review and approval by the U.S. Environmental Protection Agency (EPA) every 2 years. The purpose of the listing is to identify segments where, with technology-based pollution control measures, applicable standard(s) are not expected to be met for the listed water quality parameter(s). The EPA allowed states to skip the year 2000 303(d) list due to the ongoing development of new federal rules affecting the listing process and the TMDL program. TMDLs are prepared to restore state waters to all beneficial uses, or to prevent anticipated degradation of beneficial uses. The current active listing approved by EPA is the 1998 303(d) list. The 1998 303(d) lists Lake Garrett as impaired for total phosphorus and fecal coliforms (Ecology 1998). The preliminary draft 2002/2004 303(d) list is currently available for public review and comment (Ecology 2004). Under the amended CWA, the list is now required every 4 years instead of every 2 years. Lake Garrett is included on the draft 2002/2004 list as impaired for fecal coliforms and total phosphorus.

Comment 2: Status of TMDL Plans for Lake Garrett.

A TMDL will be prepared for Lake Garrett, but the TMDL process is not yet underway (T. Shoblom, pers. comm., 2004; B. Bennett, pers. comm., 2004). An interlocal agreement between King County, the City of Burien, the City of SeaTac, the Port of Seattle, and the Washington Department of Transportation is in place and these entities are working with citizens to identify and prioritize potential projects in the Miller/Salmon basins, some of which would improve Lake Garrett. Ecology is waiting for a final Salmon Creek Basin Plan to see what it may propose for phosphorus and fecal coliform reduction before deriving a TMDL. No phosphorus loading data have been collected for the specific purpose of formulating a TMDL that would address the fecal coliform and total phosphorus impairments to beneficial uses, and only limited data are available. Ecology interprets the available data as suggesting most of the phosphorus causing algal growth problems in the lake is from inflow, as opposed to internally derived from lake sediments.

Comment 3: Status of Phosphorus Control Recommendations for Lake Garrett in the Miller/Walker and Salmon Creek Basin Plan and in draft revisions to the King County Surface Water Design Manual

A public review draft of the Miller/Walker and Salmon Creek Basin Plan (draft Basin Plan) is planned for release in August 2004 (B. Bennett, pers. comm., 2004).

The Draft Basin Plan is expected to recommend that the following actions be included to address the phosphorus control in Lake Garrett (B. Bennett, pers. comm., 2004):

- Designate Lake Garrett as a phosphorus sensitive basin;
- In-lake treatment with alum to immobilize phosphorus in the sediment;
- Construct water quality treatment facilities within the basin;
- Public education and outreach to control phosphorus and fecal coliforms originating from pets, lawn care, car washing, and ducks and geese;
- Planting to discourage ducks and geese; and
- On-going monitoring of Lake Garrett.

Section 1.2.8.1 of the current adopted 1998 King County Surface Water Design Manual (SWDM) exempts redevelopment projects from water quality treatment requirements in excess of basic treatment level, including exemption from sensitive lake protection, resource stream protection, and sphagnum bog protection treatments. The explanation of this exemption is explained in the same section as "...application of WQ [water quality] treatment to these [redevelopment] projects incrementally reduces existing pollutant loads and concentrations to all water bodies. This benefits sensitive as well as typical water bodies and limits the cost of stormwater treatment in areas that are already developed."

In the February 2004 update draft revisions to the SWDM, the redevelopment exemption is removed, along with the explanation quoted above. Instead, if this draft version is adopted by King County Council, redevelopment would be required, like new development, to provide water quality treatment to sensitive lake protection areas and sphagnum bog protection areas where those designations have been made. King County staff anticipate sending the draft manual to King County Council for adoption in the first half of 2004, and anticipates that the revisions may be effective in late 2004 or early 2005. Our understanding is that the Greenbridge proposal is vested to the 1998 SWDM.

Comment 4: An Analysis of Impacts on Lake Garrett from Changes in Total Phosphorus Contributions Resulting from the Greenbridge

Lake Garrett is in the process of being defined as a phosphorus sensitive lake through development of the draft Miller/Walker and Salmon Creek Basin Plan, and is listed as impaired by excessive total phosphorus and fecal coliforms in the current proposed Section 303(d) list to the EPA. Although specific loading data are not available, the observed eutrophic conditions and preliminary data are sufficient to conclude that Lake Garrett would benefit from measures to reduce introduction of phosphorus to discharge reaching the lake.

Stormwater runoff from the existing site flows untreated to Lake Garrett. Redevelopment by the Greenbridge project within the Lake Garrett Basin proposes to treat stormwater runoff with a basic wet pond and wet vault designed per the 1998 King County Surface Water Design Manual (SWDM) (King County 1998). Under current adopted code, the Water Quality Core Requirement #8, Section 1.2.8.1 in the 1998 SWDM is that "Redevelopment projects subject to Core Requirement #8 need only apply the Basic water quality menu, regardless of where they are located. However, a higher standard may be imposed by an adopted resource management plan through Special Requirement #1, Section 1.3.1, or the proposed project may apply a higher standard voluntarily." A basin plan including Lake Garrett has not yet been adopted under Special Requirement #1, thus Basic wet pond facilities on the site meet requirements of the 1998 SWDM.

This analysis evaluates whether the proposed project, including basic water quality treatment, provides sufficient mitigation in the context of SEPA evaluation and in consideration of the current proposed Section 303(d) listing for total phosphorus impairment in Lake Garrett.

Existing Land Use and Total Phosphorus Load Contribution to Lake Garrett

Approximately 43 acres¹ of the existing Greenbridge project area proposed for redevelopment lies within the Lake Garrett drainage basin and drains to the lake without water quality treatment (Table 1). Lake Garrett receives drainage from approximately 600 acres within its watershed (Goldsmith & Associates 2004b). The proposed Greenbridge project would contribute approximately 7 percent of the drainage to the Lake Garrett Basin. Lake Garrett currently receives an untreated average annual runoff volume of 80.9 acre-feet year from this 43 acre area (Goldsmith & Associates 2004) (Table 1).

To estimate the total phosphorus load the existing site contributes to Lake Garrett, the untreated stormwater quality in runoff from similar single family land use within the drainage basin was derived from the literature and multiplied by the average annual volume contribution. The housing density within the 43-acre Lake Garrett drainage basin on the site is 8 dwelling units (du)/acre (Goldsmith & Associates 2004b). Untreated single family residential runoff data collected by Shapiro (1999) from the Lakemont planned residential development (4 to 7 du/acre) located in Bellevue, Washington were used to estimate phosphorus in stormwater runoff from the existing site. The existing development contains no covered parking or garages, except for a few carports constructed by some residents. Therefore, all parking is exposed to stormwater

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¹ The 43 acres excludes the Highline School District property that drains to Lake Garrett, since the District has received approvals, including drainage approvals, necessary to redevelop the site as a school. The school site is not included in this analysis.

runoff. A majority of Lakemont is single-family, but includes a small mixture of multi-family residences, a commercial center, and a community park. Residences at Lakemont include covered parking. The Lakemont data set is extensive in that it includes 3 consecutive years (1995-1998) of flow-proportionate field data. The Lakemont average untreated stormwater concentration for total phosphorus is 0.14 mg/L. The estimated existing untreated total phosphorus load Lake Garrett receives from the existing site is 13.98 Kg/year.

Table 1
Existing Condition Summary

Parameters	Existing Condition
Lake Garrett Drainage Basin On-Site (acres)	43.0
Average Annual Runoff Volume On-Site (acre-feet/year)	80.9
Dwelling unit/acre (du/acre)	8
Untreated single-family residential total phosphorus	0.14
concentration (mg/L)	
Existing total phosphorus load (Kg/year)	13.98

Re-Developed Land Use and Total Phosphorus Load Contribution to Lake Garrett

As a result of re-development, a diversion of up to 11 acres from the Lake Garrett Basin would be transferred to the Duwamish River Basin. As a result of the diversion, approximately 32.1 acres of re-development would lie within the Lake Garrett drainage basin and the Lake would receive an average annual runoff volume of 64.3 acre-feet year from the site (Goldsmith & Associates 2004b) (Table 2). Multi-family and single-family residences within the proposed on-site Lake Garrett Basin would have a density of approximately 22 du/acre, consisting of a blend of single-family detached units, single family attached or townhome units, and multi-family units. Approximately 15 percent of the re-developed site would include covered parking (garages) and all of the dumpsters serving the multifamily units would be enclosed and located within the buildings (Goldsmith & Associates 2004b).

To forecast the total phosphorus load the re-developed site would contribute to Lake Garrett, the untreated stormwater runoff for multi-family residential development was assessed. Although the drainage basin under consideration is proposed to include some single family homes, they would be densely placed and the overall density of 22 du/acre is typical of high-density multi-family land use. In addition, landscaping between buildings would be managed by a common service, which is also typical of multifamily land use. Recent and local untreated runoff data for multi-family residential development is available from the Snoqualmie Ridge project in Snoqualmie, Washington (A.C. Kindig & Co.

2002). Untreated stormwater runoff from multi-family homes was sampled 3 times in November 2002 from a catch basin that receives runoff from Snoqualmie Ridge townhomes ranging in density from 13 to 14 du/acre. This small data set was combined with data available for untreated multi-family stormwater runoff data collected by the City of Bellevue (1995) from the Goldsmith Condominiums (14 to 17 du/acre) to estimate total phosphorus content of future untreated runoff from the proposal. The Goldsmith Condominium data set includes phosphorus data from 12 storms sampled between November 1991 and March 1993. The untreated runoff consists of roofs, parking lots, access roads, and some common landscaping. A majority of the parking areas at the Goldsmith Condominiums are covered. The average of all 15 data values from the combined data sets, 0.13 mg/L total phosphorus, was used in this loading analysis to estimate the future untreated runoff condition. The slight improvement in untreated total phosphorus concentration estimates from existing (0.14 mg/L) to future (0.13 mg/L) is reasonable given project design elements that will improve on the existing condition with covered parking and trash receptacles.

Untreated stormwater runoff from the redeveloped site would be improved by transit through either a wet pond or a wet vault. Untreated runoff generated within the western portion of the on-site Lake Garrett Basin would be conveyed to a wet pond. Untreated runoff generated within the eastern portion of the on-site Lake Garrett Basin would be treated in a water quality vault.

Table 2
Re-Developed Condition Summary

Parameters	Re-Developed Condition
Lake Garrett Drainage Basin Area (acres)	32.1
Average Annual Runoff Volume (acre-feet/year)	64.3
Dwelling unit/acre (du/acre)	22
Untreated multi-family residential total phosphorus	0.13
concentration (mg/L)	

Wet Pond Contaminant Removal Efficiency

Wet ponds (or combined detention and wet ponds) maintain a dead storage volume of water that removes dissolved phosphorus by settling of fine particles, nutrient uptake by algae and fringing vegetation, denitrification, microbial degradation of organics, and sequestering of phosphorus in the sediments (Nussbaum 1990). Wet vaults are subterranean and dark, and thus lack plant-dependent removal mechanisms. This typically translates to lowered nutrient uptake. It is recognized that very dilute or low stormwater constituent inflow

concentrations are more difficult to reduce in stormwater facilities than high concentration inflows. The size, shape, and dead water depth in wet ponds are designed to dissipate hydraulic energy of water to promote settling of particulates, as well as prevent re-suspension of settled material. Efficiency for fine particle removal measured as the percentage of outflow over inflow concentrations is extremely variable from start to finish of a given storm and from storm to storm. A Basic wet pond design criterion in the 1998 King County SWDM is $V_B/V_R=3$, where the pond basin volume (V_B) is 3 times the volume of runoff (V_R) from the mean annual storm. The pollutant removal efficiency of a Basic wet pond designed to the 1998 King County SWDM criteria was estimated using pond performance data from 3 literature references (Table 3). The treated total phosphorus concentration forecast at discharge from Greenbridge to Lake Garrett is estimated to be 0.065 mg/L, based on the estimated untreated total phosphorus concentration and its removal by wet pond or wet vault (Table 4).

Table 3
Contaminant Removal Efficiencies (%) for Wet Ponds Designed to the King County 1998 Design Criterion Reported in the Literature

	Total Phosphorus Removal
Reference	Percentage (%)
A.C. Kindig 2003 ⁽¹⁾	15, 26, 50
AESI 2000 (2)	-87*, 45, 98
Herrera 2004 ⁽³⁾	81
Average Removal Efficiency ⁽⁴⁾	52
Basic Wet Pond Values Used in this Analysis	50

^{*} The inflow value for total phosphorus was measured at less than the laboratory detection level (0.005 mg/L). The inflow total phosphorus concentration is significantly less than that predicted for untreated runoff, thus this value was not included in the average

Table 4
Re-Development Forecast Total Phosphorus Concentration in Site Discharge

Stormwater Parameter	Untreated Concentration (mg/L)	Basic Wet pond or Vault Removal (%)	Forecast Total Phosphorus Concentration (mg/L)
Total Phosphorus	0.13	50%	0.065

⁽¹⁾ Three inflow and outflow concentrations measured at wet/detention pond D-1 from a single family residential development at Snoqualmie Ridge (A.C. Kindig & Co. (2003).

⁽²⁾ Three inflow and outflow samples were collected from a wet/detention pond that serves the Snoqualmie Ridge Parkway and Residential Development (AESI 2000).

⁽³⁾ Average from inflow and outflow N1 pond monitoring between October 2002 and June 2003 from Issaquah Highlands single family and multi-family development (Herrera 2004).

⁽⁴⁾ Calculated as an average of the six values shown for the three studies.

Lake Garrett is forecast to receive a total phosphorus load from the re-developed site of 5.16 Kg/year after Basic water quality treatment, the change in land use to include some covered parking, and the diversion of 25 percent of the site's contributing area out of the Lake Garrett basin. Treatment by re-development would reduce the total phosphorus load reaching Lake Garrett from the site by 63 percent from the existing load reaching the lake (Table 5).

Table 5
Total Phosphorus Load Comparison

Stormwater Parameter	Existing Condition Total Phosphorus Load (Kg/year)	Re-Developed Condition Total Phosphorus Load (Kg/year)
Total Phosphorus	13.98	5.16

In addition to a 63 percent estimated reduction in total phosphorus resulting from Basic water quality treatment and the diversion proposed by Greenbridge, there are a number of phosphorus source control measures inherent in the proposal that should be considered. These include the following:

Covered Dumpsters

Greenbridge proposes that multi-family dumpsters would be enclosed within the actual apartment buildings. Uncovered dumpsters are a source of nutrients, such as phosphorus and fecal coliforms. This source control measure would isolate the dumpsters from contributing to stormwater system.

Covered Parking

There are approximately 1072 proposed parking spaces within the onsite Lake Garrett Basin and approximately 156 of the parking spaces will be covered (15 percent covered parking) as a result of re-development. The existing development does not include any covered parking.

Lawn and Landscape Management

The existing development within the Lake Garrett Basin has 20.7 acres of currently maintained lawn. The existing lawn areas are fertilized two times a year with a weed and feed type fertilizer (Goldsmith & Associates 2004b). The Greenbridge re-development proposal would reduce the lawn and landscaping area draining to the Lake Garrett Basin by 8.4 acres, or a 41% reduction. Future lawn care and landscape maintenance is proposed to follow the "built Green" model, which recommends amended soil, mulched landscape beds, and fertilizers which are natural organic or

slow release fertilizers (Goldsmith & Associates 2004b). A reduction in nutrients resulting from landscape and turf area is expected in the Lake Garrett Basin as a result of these re-development source control measures.

Construction Evaluation

One important aspect of phosphorus loading is control of phosphorus from sediments in site drainage during construction. Phosphorous is known to readily bind to the iron and aluminum in soils in mineralized form (Sawhney and Starr 1977). Demolition and grading during construction would expose erodible soils on the site, requiring that measures be taken to prevent erosion from occurring. To avoid construction impacts, TESC measures in the 1998 King County Surface Water Design Manual, Appendix D, would be used to control sediments during construction.

The Pollution Control Hearings Board (PCHB) for the State of Washington issued an order granting a partial stay on issuance of National Pollution Discharge Elimination System (NPDES) Baseline General Permit for Stormwater Discharge Associated with Construction Activities (PCHB No. 00-173, Construction Storm Water Permit). Ecology's response to the PCHB order was to require that new construction discharges to Section 303(d) listed waters will not be allowed coverage under the Construction Storm Water Permit if the anticipated discharge will include the pollutant for which the water body is listed, unless it can be documented that no water quality violation will occur. Section 303(d) listing for phosphorus is interpreted by Ecology as being subject to this interpretation of the PCHB order. Nothing in the stay of coverage for new discharges under the Construction Stormwater permit precludes a facility from seeking an individual NPDES permit.

Since Lake Garrett is Section 303(d) listed for phosphorus, the project proposes that no runoff from areas under demolition or construction, particularly major grading contribute runoff to Lake Garrett, except from areas stabilized by hydroseeding and not releasing turbid water. This is proposed by three options which are not mutually exclusive: a) pumping runoff from areas of active construction out of the Lake Garrett Basin to the Duwamish River Basin for discharge after treatment, b) applying for an industrial waste permit from King County to allow discharge of construction water to the sanitary sewer, and/or c) using seasonal restrictions for construction in the far west portion of the site so that it can be stabilized by hydroseeding (or smaller scale plastic cover as warranted) over the winter and allowed to discharge to Lake Garrett only from the well-stabilized area. In the latter case, the project would first remove a phosphorus generating source (the existing residences) and replace it with

stabilized hydroseeded or other cover measures after demolition, clearing of demolition material, and possibly grading.

During the dry season, demolition on-site would occur within the western onsite Lake Garrett Basin draining to Mallard Lake (30 percent of the on-site area in the Lake Garrett Basin). Any runoff generated from the western area would be collected in a pond and pumped east into the eastern on-site Garret Lake Basin. The Eastern Lake Garrett Basin (approximately 70 percent of the on-site area in the Lake Garrett Basin) could feasibly gravity drain or be pumped to a large sedimentation pond. The treated water would be pumped out of the Lake Garrett Basin either to a swale constructed along a newly constructed SW 100th Street sub-collector to drain to the Duwamish River Basin, or to an existing storm drain within the present SW 100th Street in the Duwamish River Basin. During the wet season, runoff from the western Garret Lake basin can not as feasibly be diverted out of the Lake Garrett Basin due to the volumes involved. Instead this water could be discharged to Mallard Lake and Lake Garrett provided the contributing area was well stabilized through hydroseeding. To be effective, hydroseeding would need to occur by mid-September at the latest, to be well established by commencement of the wet season. Any areas actively worked in the western basin area draining to Mallard Lake would to be captured and pumped to the east, out of the basin, irrespective of season.

Analysis Conclusions

The project proposal is estimated to reduce phosphorus loadings to Lake Garrett through a combination of the following:

- 1. Basic water quality treatment;
- 2. Diversion of 25 percent of the site's contributing area to Lake Garrett out of the Lake Garrett basin (and thereby reducing phosphorus contribution from this area by 100 percent);
- 3. Reduction in fertilized lawn by 41 percent, plus additional removal through a proposed change in landscaping fertilization practices and the inclusion of soil amendments;
- 4. Plans for covered parking for 15 percent of the units where none now occurs;
- 5. Source control planning for multifamily building dumpsters by their placement under roofs; and
- 6. Control of construction runoff to avoid sediment phosphorus loading to Lake Garrett.

The first two measures alone were estimated to reduce phosphorus loads to Lake Garrett by 63 percent. This exceeds the 50 percent phosphorus reduction goal under the Sensitive Lake Protection Standards in the 1998

SWDM. The added measures 3 through 5, and particularly measure 3, though not directly quantified in this analysis, will further reduce phosphorus loading to the lake. Measure 6 will avoid a potential phosphorus load during construction.

We conclude that the combination of measures proposed, including basic water quality treatment, are sufficient to responsibly reduce phosphorus loading to Lake Garrett, and that no added measures are reasonably warranted to further lower phosphorus below existing load levels to Lake Garrett from the site.

As a result of these measures, construction-related phosphorus loading to Lake Garrett could be avoided. In the period between vacating the present site and reoccupation of the redeveloped site, phosphorus loading to Lake Garrett will be greatly reduced because there will be no phosphorus loading sources.

APPENDIX 3

GREENBRIDGE 8th AVENUE SW/ SW ROSBURY STREET MITIGATION ALTERNATIVES TECHNICAL MEMORANDUM

MEMORANDUM						
То:	King County DOT	Date:	April 14, 2004			
From:	Jennifer Lowe, Transpo	TG:	02174.00			
cc:	Richard Weinman and Mark Stuart, HWA; John Eliason, KCHA; Anna Nelson, Buck & Gordon					
Subject:	Greenbridge: 8th Avenue/Roxbury Street Mitigation Alternatives					

The purpose of this memorandum is to document and summarize several mitigation alternatives that have been considered for the 8th Avenue SW/SW Roxbury Street intersection, as it relates to the proposed Greenbridge redevelopment project.

Summary Of Findings

While sight distance limitations are caused by the vertical crest curve just west of the intersection, a condition that has existed since the roadway grid was established, the accident data does not indicate a substantial accident history. Combining accident data from both the City and County does not meet the City's criteria for HALs and the City has not previously planned any improvements for this substandard intersection; nor would it elevate the intersection to the level to be contained in the County's HAL list (requires an annual average of 8 or more accidents over the last three years). The intersection's operational characteristics, based on the calculated LOS will operate well within both the City and County's peak hour thresholds, even with the addition of project traffic. However, the City and the County have requested an exploration of mitigation for this intersection. The ten alternatives that were explored covered a varying range of options intended to address the previously noted issues at the intersection. The alternatives that were explored and analyzed are described in this memorandum. A table that summarizes the impacts of the alternatives that were explored is included as Attachment 1. It includes the identified pros and cons of the alternatives.

The only alternative that corrects all of the sight-distance limitations is the regrade to reduce the vertical crest curve (alternative 3) which addresses all sight-distance limitations. While that alternative has been available since the road system was designed, the improvement has not been undertaken as yet. The investment to make this modification is estimated at approximately \$2.5 million plus right-of-way. The dedication of the right-of-way, estimated to be approximately \$240,000 is equivalent to approximately 9 percent of the total cost for this improvement. This equates to approximately the same percent of increase in intersection volumes that the project is estimated to add to the intersection. By dedicating the right-of-way the project will provide its proportional share to this improvement, should this be identified as a future project.



Alternative 2, which adds a eastbound/westbound center left turn lane to the intersection is estimated to cost \$900,000 plus the cost of right-of-way. If taken entirely on the south side, as in above, the cost of the dedicated right-of-way has an estimated value of \$240,000. Therefore, the project would contribute approximately 21 percent of the total cost of this improvement, well over the approximately 9 percent increase in traffic that the project is estimated to add. The project will provide more than its proportional share to this improvement, should this be identified as a future project.

Alternatives that reduce the capacity for eastbound and westbound through traffic (Alternatives 6 and 7) result in intersection operations of LOS E or F for peak hours.

The applicant proposes to institute and pay for alternatives 8, 9 and 10 (restrict northbound right-turn on reds, modify signal and signal phasing to provide a phase that protects westbound left-turn movement prior to east/west green phase, and provide advance warning of signal and entering traffic to eastbound traffic prior to the crest of the hill west of the intersection). The combination of these three measures addresses the three existing sight distance issues. While only alternative 2 can completely eliminate any sight distance issues at this intersection, based on a review of the potential effectiveness to intersection safety, the combination of these modifications will improve existing safety concern identified by King County at the intersection. The resulting improvements will more than offset the potential impacts to intersection safety by the project's proportional increase to intersection volumes (less than 10 percent during peak hours). The applicant has also indicated a willingness to dedicate additional right-of-way on the northern limitations of the project site, along the south side of. The right-of-way contribution will total a value of approximately \$240,000. The right-of-way would be sufficient to accommodate future widening of Roxbury to add a center left-turn lane, should King County and/or Seattle desire to add such a lane in the future. This contribution is in proportion to the site development's contribution to future added traffic. While SEPA regulations cannot require the project to correct existing deficiencies, the applicant's proposal will not preclude such a future improvement and by dedicating the needed right-of-way, will contribute at a financial level for the estimated project cost proportional to the increase in traffic anticipated to result from the project.

Project Description

The project will include a total of 900 to 1,100 residential units (including market rate homes and condominiums, senior housing and subsidized and workforce rental units). These are in place of approximately 570 units of low-income public housing on the 93.5-acre site. Additionally, the project will add to the site public space used for a variety of community services, educational services, recreational facilities, and some commercial space. The entire project is projected to result in 340 and 470 net new vehicle trips in the AM and PM peak hours, respectively. For project trip distribution,



approximately 60 percent of project trips are expected to go through this intersection, generally follows:

- 20-25 percent to/from the north on 8th Avenue SW and Highland Park Way
- 15-20 percent to/from the west on SW Roxbury Street
- 20-25 percent to/from the northeast on SW Roxbury Street

This equates to a project contribution of approximately 9- and 8-percent increases in background project volumes in the AM and PM peak hours, respectively.

While the level of service analysis and review of accident data do not indicate major operational concerns at this intersection, public comment and a look at the available sight distances caused by the vertical crest curve just to the west of the intersection resulted in a review of several measures that would mitigate the project's impacts, and, at least in part, address concerns related to intersection safety.

Intersection Characteristics

Volumes

Traffic turning movement counts were collected for the AM and PM peak periods on November 21, 2002. The 8th Avenue SW/SW Roxbury Street intersection currently processes approximately 1,865 vehicles during the AM peak period and 2,680 during the PM peak period.

AM and PM traffic volumes for the intersection were projected for 2012 with-project improvements. The 8th Avenue SW/SW Roxbury Street intersection will process approximately 2,296 vehicles during the AM peak period and 3,256 vehicles during the PM peak period under future conditions.

Level of Service

The level of service (LOS) at the 8th Avenue SW/SW Roxbury Street intersection was evaluated for the AM and PM peak hours.

LOS is a qualitative measure of both the operating conditions of a traffic system as well as the perceived conditions by drivers and passengers. LOS is related to the physical characteristics of the roadway and the different operating characteristics of the roadway when it carries different traffic volumes. Levels of service range from LOS A, indicating good operating conditions with little or no delay, to LOS F, indicating extreme congestion and long vehicle delays. The definition of each service level and the methodology for estimating LOS is provided in the *Highway Capacity Manual* (HCM) (Transportation Research Board, 2000).

Signalized intersection LOS is defined in terms of the average total vehicle delay of all movements through an intersection. Vehicle delay is a method of quantifying several intangible factors, including driver discomfort, frustration, and lost travel time.



Specifically, LOS criteria are stated in terms of average delay per vehicle during a specified period (e.g., the PM peak hour). Vehicle delay is a complex measure based on many variables, including signal phasing (i.e., progression of movements through the intersection), signal cycle length, and traffic volumes with respect to intersection capacity. Table 1 provides the LOS calculations for the current, future without-project and with-project conditions, assuming the current intersection layout and signal timing.

Table 1

Level of Service Summary									
8 th Avenue SW/ Existing Without Project With Project							ct		
SW Roxbury Street	LOS¹	Delay²	V/C^3	LOS	Delay	V/C	LOS	Delay	V/C
AM Peak Hour	С	23.7	0.61	B^4	16.3	0.69	В	18.1	0.78
PM Peak Hour	В	16.8	0.68	В	15.2	0.77	С	29.1	0.98
 Level of service, based on 2000 HCM methodology. Average delay per vehicle (in seconds. LOS and delays represent all vehicles entering intersection. Volume-to-capacity. Assumes optimization of signal timing, resulting in improved intersection operations. 									

Under 2002 conditions, as Table 1 shows, the 8th Avenue SW/SW Roxbury Street intersection operates at LOS C during the AM peak hour and LOS B during the PM peak hours. The table also shows that the 8th Avenue SW/SW Roxbury Street intersection will operate at LOS B during the AM peak hour and LOS C during the future with project conditions. King County's LOS standard is LOS E or better at both signalized and unsignalized intersections. Seattle's Comprehensive Plan does not define a level of service standard for individual intersections. The City's operational standards are based on screenlines across specific arterials. This criteria is based on a designated v/c ratio threshold and is referred to as a "Concurrency" measure. Seattle does not require a concurrency analysis of projects located outside of City limits. The project is located in King County's concurrency "Green Zone" meaning critical roadway capacity in the project vicinity has been identified as adequate for future development. The project received notification that concurrency requirements will be met with the addition of project traffic. Operational characteristics (levels of service, LOS, calculations) at this location do not require mitigation with project added traffic which amounts to less than a 10percent increase in peak hour traffic.

Sight Distance

A field visit was conducted to determine existing sight distance at the 8th Avenue SW/SW Roxbury Street intersection. The critical sight distances are to the west of 8th Avenue SW on SW Roxbury Street, due to roadway geometry with a crest vertical curve.



Stopping sight distance (SSD) primarily impacts eastbound motorists approaching the intersection with 8th Avenue SW and their ability to see and stop for other eastbound vehicles stopped at the signalized intersection. SSD was measured from the intersection to the west in 50-foot intervals. Table 2 summarizes the measured SSD and minimum required SSD according to AASHTO, WSDOT, and King County standards.

The posted speed limit is 35 mph. As recommended in WSDOT's Design Manual Supplement, July 22, 2003, the recommended design speed for 35 MPH posted urban roadways is typically 5 mph above the posted speed. Tables 2 and 3 provide sight distance requirements based on a design speed of 40 mph. The major difference between the standards is related to both the height of the object the vehicle is moving towards and/or the height from which the object is sighted.

The City of Seattle defers to AASHTO requirements.

Table 2

Stopping Sight Distance for 40 MPH Design Speed							
From (ft)	Grade (percent)	Measured SSD (ft)	AASHTO, Seattle and WSDOT Required SSD (ft)	King County Required SSD (ft)			
0	0	290	305	325			
50	+1	285	305	325			
100	+1	275	305	325			
150	+2	265	305	325			
200	+3	270	289	325			
250	+5	275	278	325			
300	+7	280	278	325			

Table 2 indicates that at a design speed of 40 mph the King County-required SSD is not met by existing conditions at the intersection. AASHTO and WSDOT SSD are not met except for at the top of the hill. The largest discrepancy occurs at approximately 150 feet west of the intersection where 265 feet of SSD is available for approaching vehicles. This is substandard for AASHTO and WSDOT requirements by approximately 40 feet and King County standards by 60 feet.

Entering sight distance was measured for westbound left turns (WBLT) and northbound right turns (NBRT). Table 3 summarizes the measured estimated sight distance (ESD) and minimum required ESD according to AASHTO, WSDOT, and King County standards.



AASHTO Case F—"Left Turn from Major Road" applies to the WBLT maneuver and Case B2—"Right-Turn from Minor Road" applies to the NBRT maneuver.

Table 3

Entering Sight Distance for 40 MPH Design Speed							
	Measured (ft)	AASHTO and Seattle Requirement (ft)	WSDOT State Roadway Requirement (ft)	King County Requirement (ft)			
WBLT	410	325	588	555			
NBRT	345	3851	560	555			

Neither WSDOT nor King County ESD requirements are met for existing roadway conditions. The WBLT maneuver meets AASHTO and Seattle requirements, but not WSDOT or King County.

Collision Summary

A collision analysis was performed for the 8th Avenue SW/SW Roxbury Street intersection for the five-year period including 1998 through 2001. The reasons for performing a collision analysis are: (1) identify any accident pattern that may exist; (2) determine the probable causes of accidents with respect to drivers, highway, and vehicles; and (3) develop countermeasures that will reduce the rate and severity of accidents.

Accident data was requested from the Seattle Department of Transportation (SDOT) and King County. Table 4 summarizes the last five years for which collision data was available.

¹ Seattle uses the AASHTO recommended sight distance as cited in WSDOT's <u>Local Agency Guidelines</u> manual except for vehicles entering an intersection from a stop, in cases where onstreet parking is allowed.



Tahle A

			Table	4				
5 Year Accident Summary King County Plus Seattle for Intersection of Roxbury/8th								
Accident Type	1998	1999	2000	2001	2002	Total	Annual Average	
Total Accidents	8	6	5	9	7	35	7	
Right Angle – WBL & EBT	4	0	1	2	2	10	2	
Rear End - EB	0	0	1	0	0	1	0.2	

The City of Seattle has identified criteria for classifying high accident locations (HALs) as those intersections that experience above-average accident rates. Intersections with this designation would be targeted for future safety improvements in an effort to improve traffic safety and reduce the number of reported collisions. SDOT classifies a signalized intersection as a HAL if it experienced, on average, ten or more collisions per year over four or more years. An unsignalized intersection is classified as a HAL if it experienced, on average, five or more collisions per year. King County classifies high accident locations (HALs) in a list that prioritizes the most recent three year accident history. Intersections are included in the list if they experience an average of eight or more accidents per year in the most recent three years for which accident history is available. King County's HAL list developed in July 2003 does not include this intersection as a HAL as it had less than an average of 8 accidents per year. Even with a combined accident history from Seattle and King County accidents this intersection did not experience an average of eight or more accidents per year. However, the County's traffic engineer has expressed concern regarding this intersection, particularly under project conditions where new project trips will account for approximately half of the total westbound left-turn movement

Mitigation Alternatives

While, from an operational (LOS) standpoint, intersection mitigation may not be needed, and, even from a review of accident data, the intersection does not quality as a high accident location, the County and City have requested a review of potential modifications to this intersection related to the concern about potential impacts of project added traffic to the safety of this intersection. While there is no predictive model that indicates that accident experience will increase by the addition of project traffic, there is an increase in the potential for traffic accidents at study intersections. This increase in the potential for traffic accidents could be proportionate to the increase in traffic from the proposed project. Several intersection modifications were examined that could potentially address current operating conditions at the



intersection, as well as mitigate the project's impacts to this intersection. Following is our analysis of those alternatives that were reviewed.

Ten mitigation alternatives (numbered 2 through 11; alternative 1 is a no action scenario) have been considered for mitigation at the 8th Avenue SW/SW Roxbury Street intersection. Some of these alternatives are more feasible than others. Other than completely eliminating the vertical crest curve, none of the other modifications completely address all concerns related to limited sight distance at this intersection. The mitigation alternatives that were analyzed were identified during the course of the EIS analysis from both the Transportation Consultant (The Transpo Group) and King County Department of Transportation. The improvements are described in the following section. The Table in Attachment 1 summarizes all of the improvements that were considered. Alternative 1, as shown in the table, assumes no intersection modifications and serves as a basis for comparison of the alternatives.

Physical Improvements

(Alternative 2°) Widening SW Roxbury Street at 8th Avenue SW to provide eastbound and westbound dedicated left-turn lanes. The alignment of a new center-turn-lane at the intersection could potentially be placed: around the center line, which provides for the safest alignment; exclusively to the south of the turn-lane, taking all property needed along the project's frontage, which requires the greatest diversion to travel direction eastbound through traffic, or; by eliminating the existing planter strips and fitting five vehicle lanes within the resulting paved profile.

There are no established professional left-turn lane warrants or criterion for signalized intersections. The only established left-turn lane warrant for signalized intersections found in research of the topic was from Colorado³; neither approach at the intersection met any of the established warrants. The LOS at the intersection for the westbound approach is projected to operate at LOS D during the PM peak hour and LOS B during the AM peak hour, suggesting that the approach does not necessitate a left-turn lane based on operating conditions. Furthermore, if left-turn lanes were constructed at the intersection, the westbound left turn would operate at LOS D for both the AM and PM peak hours. A preliminary cost estimate for the roadway widening, if located exclusively south of the centerline, was developed by KPFF. KPFF estimated that the roadway widening, moving of utilities, and other construction costs associated with the installation of left-turn lanes would total approximately \$900,000. The required road widening would result in the loss of up to 16 units of housing. Widening the roadway would result in a longer crossing distance for pedestrians and, contrary to the project's objectives, increase the physical separation of the project from the surrounding neighborhood to the north.

For purposes of identification, Alternative 1 assumes no modifications to the current intersection layout or signal phasing.

Larimer County, Colorado Urban Area Street Standards: October 2002. The three left-turn lane warrants for signalized intersections include criteria based on the percentage of left-turning vehicles (> 20 percent), the peak hour left-turn volume (>100), or LOS operations.



(Alternative 3) Reducing the vertical curve on SW Roxbury Street to the west of 8th Avenue SW, eliminating the sight distance sight issues at the intersection. Vehicles traveling eastbound on SW Roxbury Street would be able to view the traffic signal and queues from further away, while westbound left-turning vehicles would be able to see further past the intersection to observe oncoming traffic, providing increased sight distance for both vehicle movements. This alternative would require major revisions to the topography of SW Roxbury Street and its intersection with public roadways to the west of 8th Avenue SW/SW Roxbury Street. KPFF estimated that this improvement would cost approximately \$2.5 million.

(Alternative 4) Moving the southern approach of the 8th Avenue SW intersection to the east, further away from the vertical curve, in order to improve sight distance. This alternative would result in the shift of the southern approach to at least 250 feet east of its current location to meet sight distance requirements. However, doing so would leave the northern leg of the 8th Avenue SW/SW Roxbury Street intersection at its current location and offset the intersections to the degree that they would likely not meet King County intersection spacing standards. King County standards require 1,000-foot spacing between adjacent intersections on principal arterials (SW Roxbury Street is designated as a principal arterial by the City of Seattle). If both the northern leg and southern leg of the resulting offset intersection were signalized, progression and maneuvering for turns between the two intersections would likely result in increased delays on SW Roxbury Street and create additional safety hazards. In addition, such a move would cause major revisions to the proposed master plan and internal circulation. Doing so would route a large volume of traffic through residential streets.

Operational Modifications

This section describes a variety of modifications to the operations of this intersection which were also analyzed.

(Alternative 5): Prohibit westbound left turns from SW Roxbury Street onto 8th Avenue SW. In this alternative, vehicles currently completing this left turn and new southbound vehicles coming from the east would reroute to the 4th Avenue SW/SW Roxbury Street intersection, and use SW 100th Street to access 8th Avenue SW or other local roadways. Doing so would introduce approximately 100 additional PM peak hour trips, and 30 AM peak hour trips to SW 100th Street. SE 100th Street has been designated as a subcollector, with traffic serving local roadways in the development. It would be desirable for these vehicles to continue to use 8th Avenue SW since it is designated as a neighborhood collector and intended for much higher traffic volumes. If westbound left turns were restricted at the 8th Avenue SW/SW Roxbury Street intersection, this would shift this traffic to 4th Avenue SW and then to SW 100th Street. The resulting shift in traffic would potentially result in the need for changing the intended roadway classification to a neighborhood collector. This roadway does not provide the needed sight distance at certain locations to meet the



related speed design for this classification of street. A new neighborhood elementary school and a Head Start facility will be constructed along SW 100th Street, making the addition of these trips to the roadway a safety concern. It also has potential to cause negative consequences to the success of commercial businesses and community services that will be located on site, along 8th Avenue SW.

(Alternative 6): Convert SW Roxbury Street to one through lane in each direction with a two-way center left-turn lane, with eastbound and westbound left-turn lanes at the 8th Avenue SW/SW Roxbury Street intersection. Because of the high through volumes on this roadway, reducing the capacity to this degree would result in operational conditions of LOS F. Providing such a lane would allow a protected left-turn phase to be programmed in the signal phasing, which would help eliminate potential WB left turn decision issues. However, it would not address EB stopping movements or NB right turn decision movements.

(Alternative 7): Convert SW Roxbury Street to include two through lanes in the westbound direction, and one through lane in the eastbound direction. This would allow for the construction of a westbound left-turn lane at the 8th Avenue SW/SW Roxbury Street intersection. However, like Alternative 6, the reduced capacity for westbound through movements would result in operations of LOS F and E for AM and PM peak hours, respectively.

(Alternative 8): Restrict northbound right turns to not allow right-turn-on-red. This will help alleviate concerns for NB decision sight distance though the queue for northbound traffic would be expected to increase. With the existing configuration of the intersection's south leg, enforcement of this restriction could be an issue. Modifications to the south leg, which would provide only enough width for one northbound lane at the intersection would provide less opportunity for disregard of a restriction. The restriction of northbound right-turns-on-red in Alternative 8 results in no noticeable increase in delay at the intersection as a whole from those operating conditions in the No Improvement alternative. This mitigation measure, intended to address sight distance limitations for this movement, can be expected to not cause a significant impact upon intersection operations.

(Alternative 9): Add a leading protected phase for the westbound left turn.

This alternative rephases signal and signal timing to allow for a protected westbound left-turn movement prior to the full east/west permitted and through phase (a lead phase). This allows some protected accommodation for the left-turning vehicles at each cycle. Although LOS and delay results do not indicate that this phase is necessary, it would help drivers use better judgment in determining adequate gaps for making this movement, given the knowledge that safe protected movement will be available during each cycle, if necessary. The intersection changes to LOS D in PM peak hour conditions, although only 0.2 second of average delay per vehicle is added as a result of the intersection revisions. In the AM peak hour, the intersection changes



to LOS C (from LOS B) with approximately 27 seconds of average delay per vehicle as a result of the intersection revisions (see Attachment 3). This alternative provides protected left-turn opportunities for westbound left-turning vehicles within the existing shared left/through lane. Maximizing the protected phase in the signal cycle, while still providing an LOS of D would provide protection for approximately 40 percent of total westbound green phase of signal.

A 1994 study of 63 at-grade signalized intersections resulted in a predictive model that indicated that a protected left-turn lane has a positive effect on safety. A typical example developed from the model indicates an anticipated reduction in left-turn accident rate of approximately 50 percent from installation of a protected left-turn signal phase⁴.

(Alternative 10): Provide advance warning measures for eastbound traffic.

Measures could include the standard cautionary sign showing a graphic of a signal, along with number of feet from sign to the intersection and/or a flashing yellow light. These measures would alert eastbound traffic to the potential stopping and entering vehicles ahead which may be within the location of limited sight distance.

(Alternative 11): Institute a modified speed zone in the project vicinity. Because of the vertical crest curve, existing conditions dictate this area of Roxbury is more suitably signed for a lower posted speed limit. The vertical crest curve limits the stopping sight distance. At a more appropriate posted speed limit of 30 MPH, the roadway curvature provides adequate stopping sight distance for design speed of 35 MPH by AASHTO, King County and WSDOT design standards and AASHTO recommended minimum sight distance for westbound-left turning and northbound right-turning movements.

Potential Effectiveness to Intersection Safety

In April 2004, The US Department of Transportation, Federal Highway Administration and Institute of Transportation Engineers issued a brief titled "Toolbox of Countermeasures and Their Potential Effectiveness to Make Intersections Safer." The brief included most of the potential mitigations described in the previous section. The following table is based on that analysis and provides that brief's findings related to the specific measures considered for this intersection.

⁴ Maze, T.H., J. L. Henderson, and S. Sankar. *Impacts on Safety of Left-Turn Treatment at High-Speed Signalized Intersections*, Iowa Highway Research Board Project HR-347, Iowa State University, January 1994.



Potential Effectiveness¹ (In Percentage Reduction in Accidents)

Improvement	^t Type (Alt #)	Relative Cost	% Reduction in Total Crashes	% Reduction in Right Angle Crashes	% Reduction in Left Turn Crashes	% Reduction in Rear- end Crashes	% Reduction in Sideswipe
2: Construc Signal U	ct Left-Turn Lane with ogrades	High	•		•	•	
Realignn effective	tal/Vertical Curve ment (potential eness only given for non- ed intersection)	High	•				
Curve (p	ersection Away from notential effectiveness only r non-signalized tion)	High	25%				
	WB Left-turns (Not in Brief)						
with Sigi Brief doe	nstruct Left-Turn Lane nal Upgrades (as Alt 2. es not analyze ation with reduction in lanes)	High	٠		•	٠	
8: Restrict/	/Eliminate RTOR	Low	20-25%				
9: Add Pros Phase	tected/Permissive LT	Medium	4–10%		40-64%		
10: Install Si	IGNAL AHEAD Sign	Low	3-40%	35%		•	•
(reductio	eduction and Enforcement on only noted for an related accidents)	High					

1. Toolbox of Countermeasures and Their Potential Effectiveness to Make Intersections Safer, USDOT, FHA, ITE, April 2004.

Bullet represents a countermeasure/crash type identified; however, no estimate of effectiveness is provided.

Proposed Mitigation

The applicant proposes to institute and pay for alternatives 8, 9 and 10 (restrict northbound right-turn on reds, modify signal and signal phasing to provide a phase that protects westbound left-turn movement prior to east/west green phase, and provide advance warning of signal and entering traffic to eastbound traffic prior to the crest of the hill west of the intersection). The combination of these three measures addresses the three existing sight distance issues. While only alternative 2 can completely eliminate any sight distance issues at this intersection, based on a review of the potential effectiveness to intersection safety, the combination of these modifications will improve existing safety concern identified by King County at the



intersection. The resulting improvements will more than offset the potential impacts to intersection safety by the project's proportional increase to intersection volumes (less than 10 percent during peak hours). The applicant has also indicated a willingness to dedicate additional right-of-way on the northern limitations of the project site, along the south side of. The right-of-way contribution will total a value of approximately \$240,000. The right-of-way would be sufficient to accommodate future widening of Roxbury to add a center left-turn lane, should King County and/or Seattle desire to add such a lane in the future. This contribution is in proportion to the site development's contribution to future added traffic. While SEPA regulations cannot require the project to correct existing deficiencies, the applicant's proposal will not preclude such a future improvement and by dedicating the needed right-of-way, will contribute at a financial level for the estimated project cost proportional to the increase in traffic anticipated to result from the project.

Attachment

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Attachment 1: 8 th Avenue SW/SW Roxbury Street: Improvement Alternatives ¹											
Improvement Alternative	Advantages	Disadvantages	Sight Distance Limitations Addressed?			AM Peak Hour Conditions			PM Peak Hour Conditions		
			EB Stoppi	NB	WB Left	LOS ²	Delay 3	V/C 4	LOS	Delay	V/C
Alternative 1: Leave intersection as- is	*Allows everyday drivers to manuever and adjust travel patterns as they have in the past based on the current intersection configuration	*Does not address perceived safety issue at the intersection *Does not address limited sight distance that have	N	N	N	В	18.1	0.78	С	34.9	1.01
Alternative 2: Construct Eastbound and Westbound left- turn lanes (could align centrally with widened roadway, potentially with elimination of landscape strips and lane restriping, or asymetrically, which would require more route deviation for EB through traffic, and longer	*Separates left turns from through traffic *Improves traffic flow on SW Roxbury Street *Provides protected phase for WB left turn, which has limited	*Estimated \$900,000 cost plus right-of-way *Wider street for pedestrians to cross *Creates further separation of Greenbridge from community to the north *Results in loss of up to 16 housing units from proposed Master Plan *Asymetrical alignment introduces approach offset	N	N	γ	С	26.6	0.82	С	28.8	0.84
Alternative 3: Revise natural topography of vertical curve located to the west of the intersection	*Removes sight distance limitations at the intersection	*Estimated cost \$2.5 Million + right of way *No measurable improvement to LOS conditions	Υ	Υ	Υ	В	18.1	0.78	С	34.9	1.01
Alternative 4: Move southern approach of 8 th Avenue SW further to the east	*Creates space between southern approch and the vertical curve/sight distance issues *Eliminates EB stopping sight distance limitation issue	*Would create offset intesections that would not meet KC intersection spacing standards (>1,000 feet for arterials) and impede progress of through traffic with additional signal *Would require major changes to the proposed Greenbridge Master Plan *Would create weaving between the two intersections involving existing and new project trips *Would send higher levels of traffic, including commercial traffic and transit, through residential neighborhoods	N	Y	Y	-				-	-

Improvement Alternative	Advantages	Disadvantages	Sight Distance Limitations Addressed?			AM Peak Hour Conditions			PM Peak Hour Conditions		
			EB Stoppi	NB Riaht	WB Left	LOS ²	Delay 3	V/C ⁴	LOS	Delay	V/C
Alternative 5: Restrict westbound left turns from SW Roxbury Street	*Removes WB left turns from through traffic *Improves traffic flow on SW Roxbury Street	*Would likely shift 1,000 daily, 100 PM peak hour, and 30 AM peak hour trips to 4 th Avenue SW and eventually SW 100 th Street *May require the reclassification of SW 100 th Street from subcollector roadway *Not compatible with sight distance issues on SW 100th Street *Would introduce additional traffic to roadway adjoining a planned Elementary School and Head Start *Effectiveness highly contigent upon enforcement	N	N	γ	В	17.0	0.75	В	17.0	0.80
Alternative 6: Convert SW Roxbury Street to 1 lane in each direction with a center left-turn lane	*Provides protected phase and lane for the WB left turn, which has limited sight distance *Narrower street for pedestrians to cross	*Results in intersection operating at LOS F during both the AM and PM peak hours *Significantly reduces the vehicle capacity of SW Roxbury Street	Ν	N	Y	F	88.8	1.15	F	136.0	1.28
Alternative 7: Convert SW Roxbury Street to include 2 westbound through lanes (and EB/WB left-turn lanes) and 1 eastbound through lane	*Provides protected phase and lane for the left turns, adressing WBLT sight distance limitation	*Results in intersection operating at LOS F during the AM peak hour, and LOS E in the PM peak hour *Significantly reduces the vehicle capacity of SW Roxbury Street in the eastbound direction	N	N	Y	F	86.8	1.15	Ε	64.2	1.12
Alternative 8: Restrict northbound right turns from turning on red	*Limits the exposure for NB right-turning vehicles to collide with EB vehicles due to the limited sight distance *Due to the relatively low volumes on this approach, the operations impact is minimal	*Effectiveness highly contigent upon enforcement (note that modifications to the south leg could help enforcement)	N	Y	N	В	18.1	0.78	С	34.9	1.01
Alternative 9: Provide a protected+permitted WBL turn phase with the existing channelization	*Provides a protected phase for the WB left turn within the existing right-of-way *Would operate at an acceptable LOS during the AM/PM peak hours	*Only benefits WB left-turning vehicles that arrive at the stop bar during the protected phase	N	N	Y	С	26.8	0.87	D	35.1	1.01

Improvement Alternative	Advantages	Disadvantages	Sight Distance Limitations Addressed?			AM Peak Hour Conditions			PM Peak Hour Conditions		
			EB Stoppi	NB Riaht	WB Left	LOS ²	Delay 3	V/C ⁴	LOS	Delay	V/C
Alternative 10: Provide advance warning measures for eastbound traffic.	*Alerts EB traffic west of intersection to potential conflicts that may or may not be visible	None	Y	N	N						
Alternative 11: Reduce speed on Roxbury	*Lowe travel speeds provide adequate sight distance to meet AASHTO standards, particularly for EB Stopping sight distance limitations	*Highly reliant on enforcement	Y	Υ	Υ						

- Conditions/volumes referenced represent 2012 conditions with the proposed Greenbridge Master Plan
- Level of service, based on 2000 HCM methodology
 Average delay per vehicle in seconds
 Volume-to-capacity ratio for signalized intersections